epiphytic populations of Xanthomonas phaseoli (E. F. Smith) Dows. on red kidney bean, and 3) to investigate the relationship between SO_2 dose and common blight development.

8.3.2. Materials and Methods

8.3.2.1. Plant Culture

A field plot (61 m x 12 m) was planted to red kidney bean (Phaseolus vulgaris L. cv. 'California Light Red Kidney') on 3 June using standard commercial practice and recommended fertilizer applications (Sansted et al., 1980). The soil in the plot had been characterized and reported earlier (Kohut, 1981).

After emergence, four uniform areas (blocks) were selected and open field fumigation devices were put in place. Plants were harvested in September when plants were fully mature and defoliated.

8.3.2.2. SO_2 Exposures

Open field fumigation devices (Laurence et al., 1982) were modified to provide three general fumigation levels of SO_2 (0, low, and high). Levels varied somewhat from block to block in the field depending on wind and plant canopy conditions.

Monitoring of SO_2 was conducted using Series 43 Thermoelectron Pulsed Fluorescent SO_2 Analyzers and sequential sampling values. There were 11 monitoring points in each block and each point was selected approximately every 40 minutes during fumigation. Exposures were conducted on 11 occasions from 17 July to 27 August. Each exposure lasted approximately 3 hr. A summary of SO_2 concentrations during fumigations is give in Table 8.3.1.

8.3.2.3. Experimental Design

The original experimental design utilized three SO_2 treatments in randomized blocks. Upon examination of the air monitoring data, it became obvious that SO_2 doses were not comparable from block to block and so SO_2 doses were computed for each row of treatment in each block and data were analyzed using regression techniques.

8.3.2.4. Inoculation and Disease Assessment

Greenhouse grown plants were inoculated with Xanthomonas phaseoli on 3 July and maintained until symptoms of common blight (large watersoaked areas) were present. On 13 July, one infected plant was placed in the center of each treatment plot, and sprinkler irrigation was applied for approximately 4 hr to facilitate the spread of the pathogen. These plants were removed on 16 July. On 27 July, one plant in the center of each plot was inoculated with X. phaseoli in an attempt to initiate an epidemic in the plots.

TABLE 8.3.1. MEAN SO_2 CONCENTRATIONS AND SO_2 DOSES (PPM-HR) IN PLOTS INOCULATED WITH *XANTHOMONAS PHASEOLI*

	Block							
	A		B		C		D	
Treatment	Mean Conc.	Dose	Mean Conc.	Dose	Mean Conc.	Dose	Mean Conc.	Dose
SO_2 1	0.23	7.55	0.33	10.91	0.35	11.58	0.13	4.44
SO_2 2	0.65	21.64	0.22	7.29	0.48	15.73	0.36	12.12
Control	0.01	0.29	0.01	0.44	0.02	0.69	0.02	0.79

Leaf prints (to monitor epiphytic populations of X. phaseoli) were made weekly by pressing a trifoliate leaflet on a plate of rifampin agar (Weller and Saettler, 1980). In addition, beginning on 14 August, leaves were collected from each of four locations near infected plants, washed to remove epiphytic bacteria, and plated to determine populations of X. phaseoli.

Visual surveys to detect SO_2 injury, common blight, insect activity, and other diseases were made twice weekly.

8.3.3. Results

8.3.3.1. SO_2 Injury

Symptoms of SO_2 injury were not abundant and usually consisted of chlorosis of lower leaves and exposed plants. Occasionally, interveinal necrosis was observed on young leaves.

8.3.3.2. Effects of SO_2 on Yield of Red Kidney Bean

The correlations between SO_2 seasonal dose and both seed dry weight and seed number were low (0.157 and 0.105, respectively), indicating that doses of up to 21 ppm-hr over a 7-week period did not significantly affect the yield of kidney bean. Several regression models were attempted, but did not improve the relationship.

8.3.3.3. Effects of SO_2 on Common Blight of Bean

Common blight was not successfully established in the field plots in spite of inoculation and other practices conducted to encourage the pathogen.

Epiphytic populations of the pathogen were established (Figures 8.3.1 to 8.3.4) but never reached the levels reported to cause symptoms (Weller and Saettler, 1980).

Late in the season (mid-August) the plants became infected with Isariopsis griseola (causing angular leaf spot) from natural sources. This pathogen caused extensive defoliation of the plants and probably was responsible for halting the development of X. phaseoli. Analysis of SO_2 dose and angular leaf spot severity showed a moderate correlation ($r = -0.34$), indicating a reduced angular leaf spot severity in SO_2-treated plots. This correlation was marginally significant ($p < 0.10$) and conclusions should be drawn carefully since the relationship is based on only one assessment of angular leaf spot severity.

Discussion

Results of these studies agree with those of Kohut (1981) regarding the effects of periodic, low concentration SO_2 exposures on the yield of red kidney bean. It appears that the plants are not particularly sensitive to SO_2, even during the pod-filling stage where elevated ozone concentrations have been shown to reduce yield (Kohut, 1981).

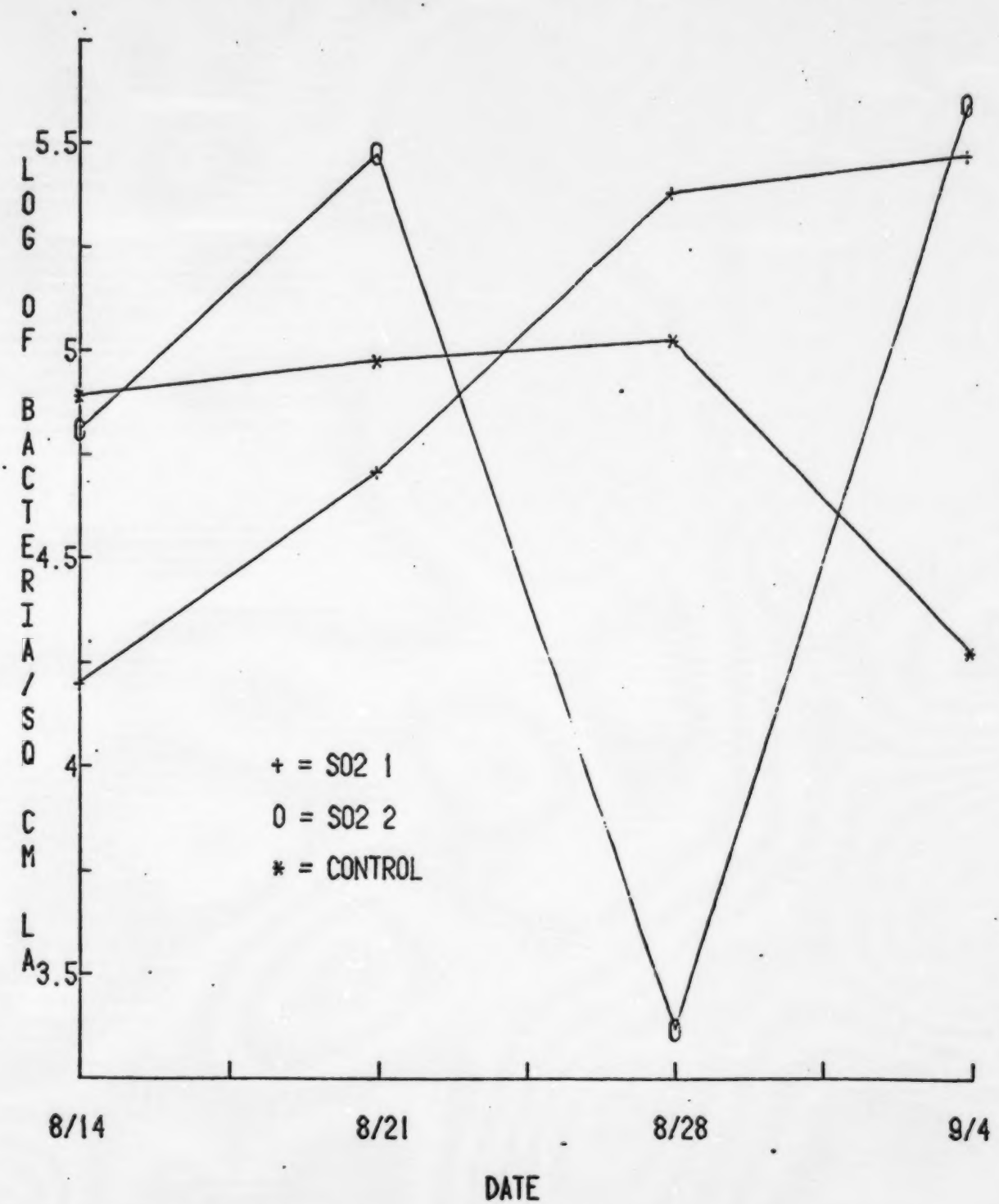

Figure 8.3.1. Epiphytic populations of Xanthomonas phaseoli on trifoliate leaves adjacent to inoculated plants.

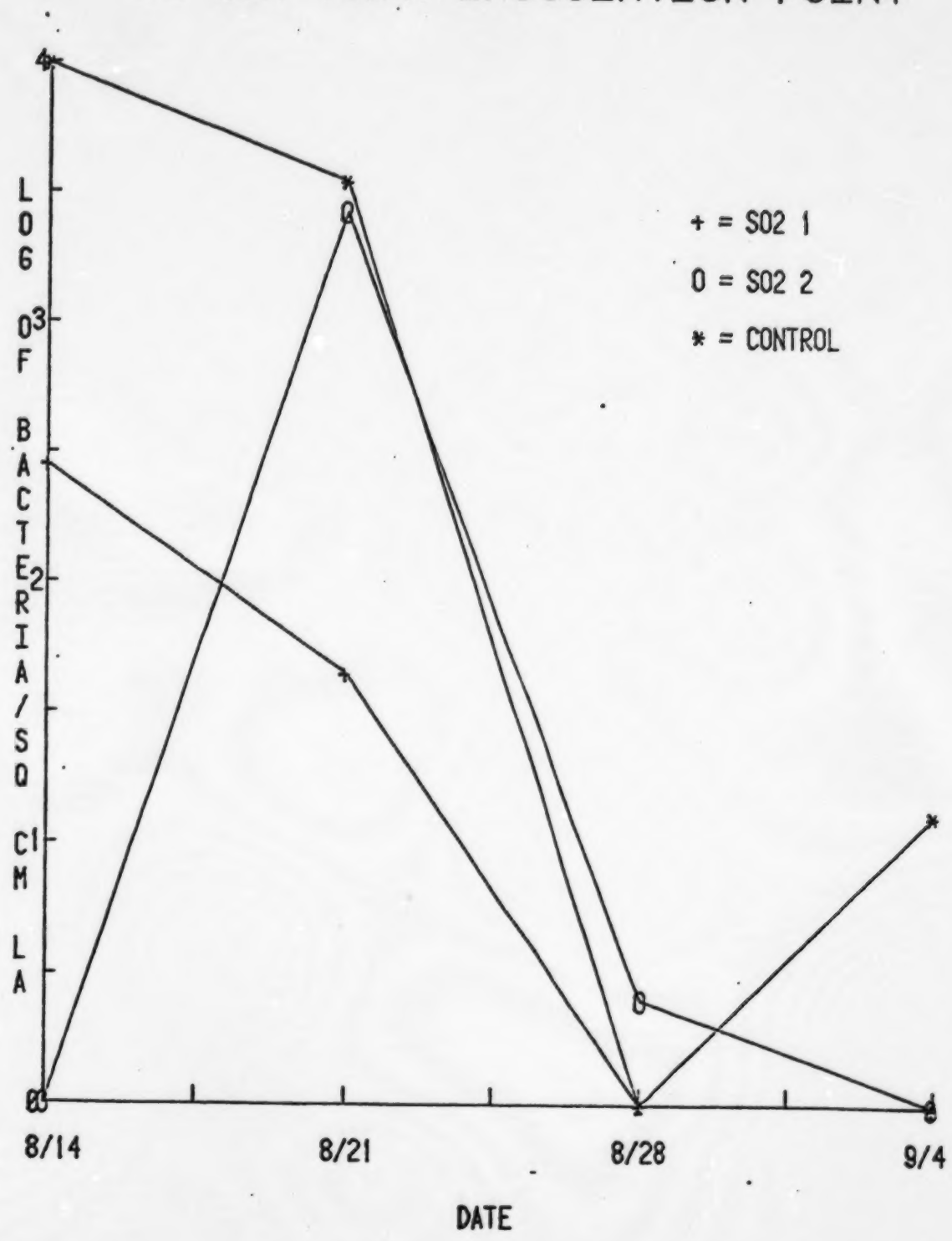

Figure 8.3.2. Epiphytic populations of Xanthomonas phaseoli on trifoliate leaves 0.66 cm from inoculated plants.

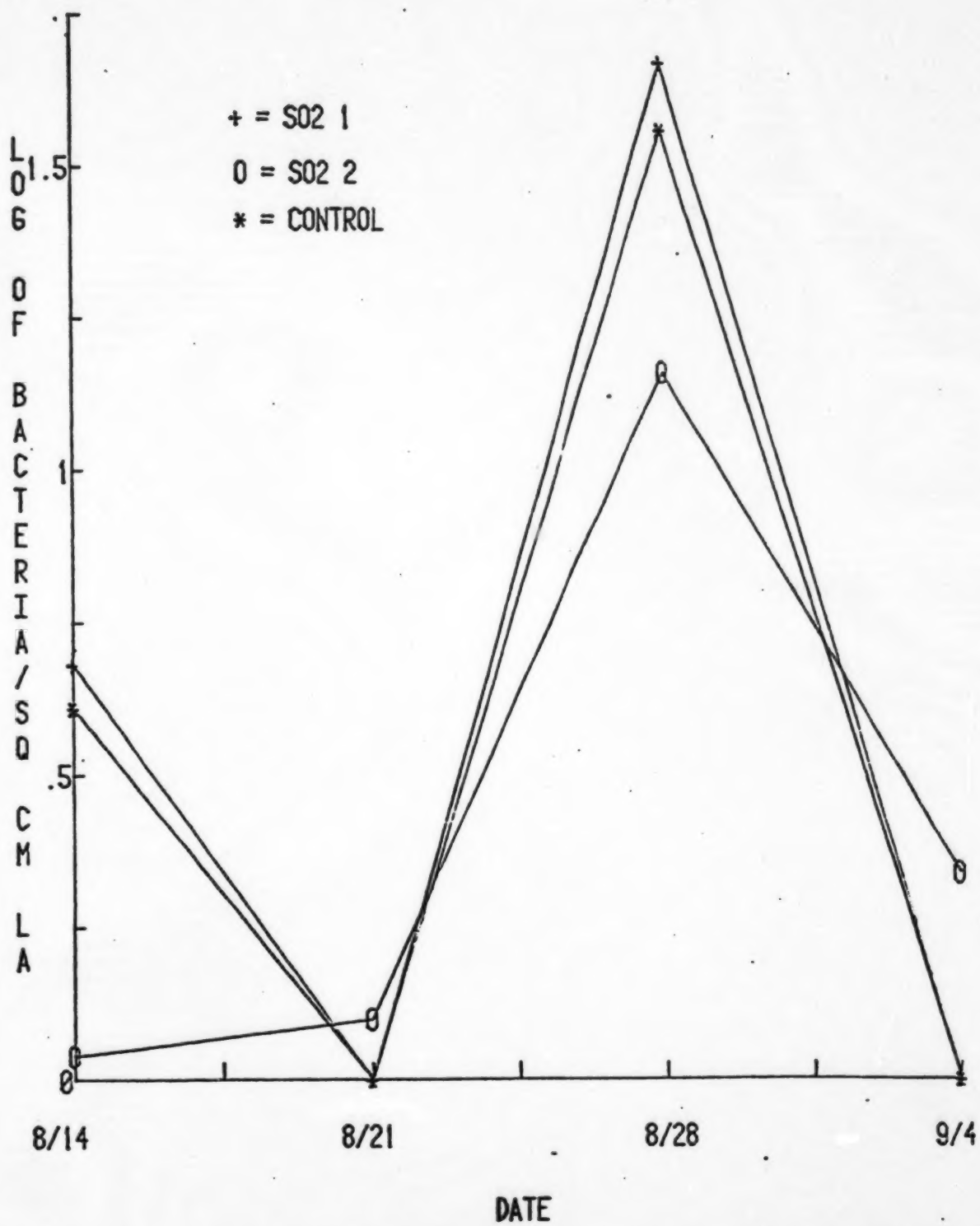

Figure 8.3.3. Epiphytic populations of Xanthomonas phaseoli on trifoliate leaves 1.43 cm from inoculated plants.

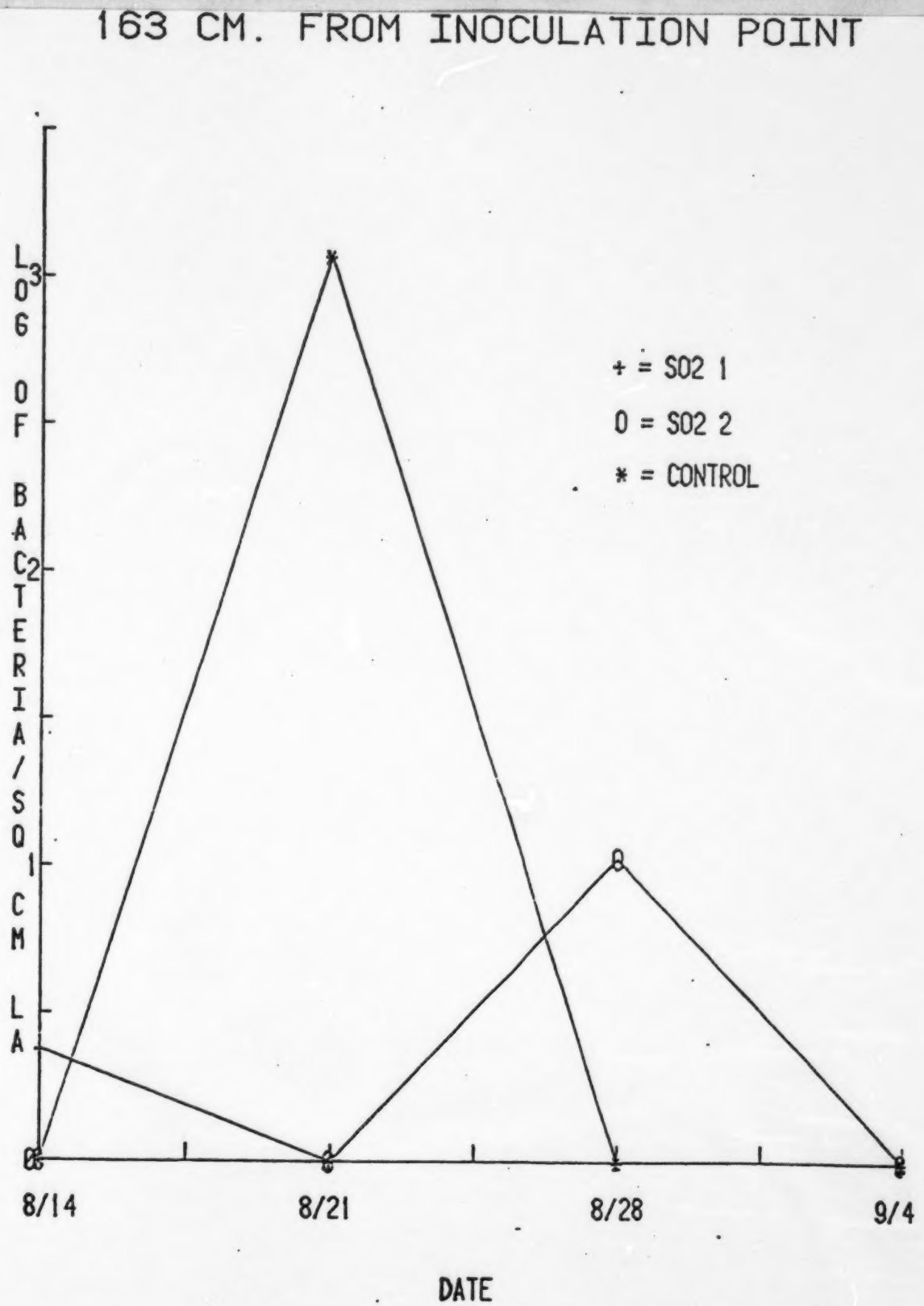

Figure 8.3.4. Epiphytic populations of Xanthomonas phaseoli on trifoliate leaves 1.64 cm from inoculated plants.

Since a common blight epidemic did not develop, it is not possible to draw conclusions concerning the effects of SO_2 on disease development. Analysis of epiphytic populations did not indicate a significant effect of SO_2 on this stage of the disease cycle, but did show that the bacterium was surviving and in some cases multiplying in the presence of SO_2. Late season population declines were probably due to defoliation of plants by the angular leaf spot fungus.

The effects of SO_2 on angular leaf spot are open to speculation. Since the infection was natural, uniformity of inoculation cannot be assumed and, therefore, firm conclusions cannot be made. The moderate correlation between angular leaf spot and SO_2 dose does indicate an inhibitory effect as seen with many other fungal diseases, but confirmation of these results would require further experimentation.

SECTION 9

APPENDIX

9.1. Biological Quality Assurance Annual Report*

Since generalized quality assurance (QA) methods for NCLAN related biological measurements were unavailable, the first of its kind biological quality assurance plan (BQAP) was developed for use at all six NCLAN locations. Those measurements (plant weight and soil moisture) common to most stations along with procedures for data handling are initially in the BQAP. Each location is responsible for developing QA plans for site specific measurements such as for physiology and quality parameters. Once approved by appropriate EPA and NCLAN officials they become part of the NCLAN BQAP. There were no site specific QA plans submitted for approval in 1981. The researchers were establishing techniques and optimal procedures for which QA guidelines can be established in 1982.

The NCLAN BQAP received final approval on July 23, 1981. By this date research studies at the experimental locations were in progress, making it impossible to follow all phases of the QA plan. Calibration checks for weight measurement QA forms returned to the NCLAN BQAL indicate the weighing was done well within the 1 percent uniformity guidelines. Almost all weights were within 0.1 percent of the true weight.

Dr. Herbert C. Jones of TVA's Air Resources Program visited each field site as a check on the overall program during the period July 26 - August 6, 1981. He said in his report, "I was favorably impressed with the overall conduct of the experiments and the attitude and enthusiasm of the researchers." There appeared to be no significant problems with respect to the experimental setup and adherence to procedures considering the short time permitted between completion of the annual NCLAN planning process and implementation of the 1981 summer studies and considering budget and manpower limitations."

A BQAP questionnaire was mailed to each site in December 1981 to determine how closely QA procedures were followed at each location. Results indicate most sites were able to complete all QA guidelines for plant weights and data handling procedures. Due to the late approval date for QA guidelines, only one site did a pre-season uniformity check of soil moisture probes. All of the questionnaires and other returned QA forms will be kept on file in Corvallis.

In 1982, site-specific QA plans developed in 1981 will be submitted for approval by each site prior to the 1982 growing seasion. Thus, nearly all biological measurements will be made following established guidelines. Adherence to QA plans will again be monitored through use of a questionnaire and personal communication.

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* Grady E. Neely, Corvallis Environmental Reserach Laboratory, Corvallis, Oregon.

SECTION 10

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